be relayed to another network, transmits the packet to the transmitting packet editing unit 612 and inputs a reply instruction to a reply generation unit 641 (see Fig. 43).

Then, the reply generation unit 641 generates packet "ack-pending" for indicating that a formal reply packet is returned later and transmits the packet to a serial bus via the IEEE1394 adapter 611 as a reply packet (see Fig. 43).

In this way, the relay device 610s that takes charge of the relay process of an asynchronous packet can return a reply packet in place of the destination node.

Since a time required to return the reply packet described above is the same as that required to output a reply packet to an asynchronous packet addressed to the relay device 610s, the reply packet can be outputted to a serial bus within a specified time after the transmitting node transmits the asynchronous packet to a serial bus and the transmitting operation of the asynchronous packet can be normally completed.

As shown in Fig. 43, an asynchronous packet is transformed into a relay packet by the transmitting packet editing unit 644, is further reshaped into an IP packet by the encapsulation unit 613 and is

transmitted to the Internet via the Internet adapter 713 (see Fig. 40).

In this case, the virtual ID reading unit 651 of the transmitting packet editing unit 644 reads corresponding virtual ID "Vs2" from the node ID table 645 based on node ID "1" designated by an originating field according to an instruction from a transmitting side control unit 618 (see Fig. 42C) and returns the ID to the transmitting side control unit 618.

In this case, the control information editing unit 617 also replaces a node ID included in the originating field of an asynchronous packet (shown by shading in Fig. 44B) using the virtual ID described above according to an instruction from the transmitting side control unit 618.

In this way, a relay packet both the destination and originating source of which are indicated by a virtual ID is generated. When this relay packet is inputted, the encapsulation unit 613 generates an IP packet by attaching an IP header with the network address of the self-device and the network address of the relay device 610r connected to the second network as an originating source and a destination, respectively, and transmits the packet to the Internet via the Internet adapter 713.

As shown in Fig. 43, after being received by the Internet adapter of the relay device 610r, this IP packet is transformed back to the relay packet by the header eliminating process of the decapsulation unit 621 and inputted to the receiving side editing unit 647.

In this case, the node ID reading unit 652 shown in Fig. 42A receives a virtual ID indicated in the destination field from the receiving side control unit 624, reads a node ID correct in the second network from the node ID table 645r based on this virtual ID and returns the ID to the receiving side control unit 624.

Next, since the control information editing unit 617 replaces a node ID included in the destination field of the relay packet (shown by shading in Fig. 44B) with this node IDs according to instructions from the receiving side control unit 624, the relay packet is converted to an asynchronous packet with a node indicated by a node ID correct in the second network (for example, node number 1), as shown in Fig. 44C.

In this way, the transmission/reception of an asynchronous packet can be implemented between two nodes belonging to different networks regarding the first and second physically independent networks as one virtual network.

In this way, correct commands and replies can be transmitted/received according to a function control protocol (FCP) stipulated in the IEEE1394 standard regardless of physical distance. For example, a device connected to the first network can control the operation of a device connected to the second network.

In this case, according to the data communications system of the present invention described above, in a relay packet both a destination node ID and an originating node ID are represented by virtual IDs and the virtual IDs are converted to node IDs correct in each of the first and second networks.

Therefore, an asynchronous packet can surely be delivered to a target node, regardless of whether bus reset is made or not in a network to which the destination node belongs.

When in such a relay device 610 both the destination and originating source of an asynchronous packet are managed by a virtual ID, it is sufficient if the correspondence between the virtual ID and the node ID in the network is managed in each of networks participating in communications. Therefore, the management process of a node ID table is very simple, as described later.

Next, a method for managing a node ID table when bus reset is made is described using a relay device 610r connected to the second network as an example.

Fig. 45 is a flowchart showing the operation in relation to bus reset. Fig. 46 shows the operation in the case where bus reset is made.

When reset notification is inputted from an I/F control unit 614 of the IEEE1394 adapter 611 (see Fig. 46), the node information collection unit 646 shown in Fig. 40 detects the generation of bus reset (step A321 in Fig. 45) and first checks a node number provided to the self-device (step A322 in Fig. 46).

In this case, a route judgment unit 648 receives the node number from the node information collection unit 646 (see Fig. 46) and judges whether this node number indicates a route node (step A323).

If judgment in step A323 is yes, the reset signal transmitting unit 649 shown in Fig. 40 instructs the I/F control unit 614 of the IEEE1394 adapter 611 to output a bus reset signal. Then, the I/F control unit 614 controls the operation of the IEEE13294 interface 616 to output a rest signal to a serial bus and to reset the bus (step A324).

In this way, since the relay device 610 makes bus reset and demands the retry of a route node

assignment when a route node is assigned to the relay device 610, the relay device 610 can be surely prevented from becoming a route node.

In this case, most of the IEEE1394 adapters currently put into the market are not provided with functions to be stipulated in the specification of the IEEE1394 standard as a route node. However, most of both digital video cameras and digital video decks put into the market are surely provided with the functions stipulated in the specification.

Therefore, by preventing the relay device 610 from becoming a route node and applying a technology to enable another node to take charge of the route node, the relay device 610 can be implemented using the IEEE1394 adapter in the market without ant modification. Furthermore, a normal synchronous transfer can be guaranteed.

If bus reset is made, as described above, the node information collection unit 646 stops the node information collection and restarts the node information collection when new bus reset is made.

If the judgment in step A323 is no, the node collection information unit 646 continues the collection of node information and collects node information about all the nodes belonging to the second

network (step A325).

In this case, for example, as shown in Fig. 46, the node information collection unit 646transmits a serial number read request packet (shown as a serial number request in Fig. 46) to all the nodes but the self-device belonging to the second network and extracts an originating node ID included the header as well as a serial number reported by the reply packet (shown as serial number notification in Fig. 46).

Then, the node information collection unit 646 retrieves a corresponding entry from the node ID table 645, updates the content of the node ID table 645 by storing the node number extracted from the originating node ID as a new node ID (step A326) and terminates the process.

The same process applies to the collection of node information of the node information collection unit 646 of the relay device 610s on the first network side.

In this way, since the node information collection unit 646 performs the simple process described above every time there is bus reset, node information about the correspondence between a node belonging to each network and a virtual ID can be always kept latest.

However, if bus reset is made by the addition of a new node, there is no entry corresponding to a notified serial number.

In this case, the node information collection unit 646 generates a new entry in the node ID table 645 by assigning a new virtual ID to a node specified by the notified serial number and stores the node number extracted from the originating node ID as a corresponding ID.

In this case, if an IOP packet in a correct format, including the pair of a serial number and a virtual ID described above is generated and is transmitted to another relay device 610 via the Internet adapter 713, node information about a node added to each network can also be shared by the relay devices 610 connected to the network.

If a relay device 610 is connected to each of three or more physically independent networks and a unique virtual ID is assigned to each of all the nodes belonging to these networks, similarly, an asynchronous packet can be transmitted/received regardless of the boundary of physical networks regarding these networks as one virtual network.

The data communications system is applicable not only a network based on the IEEE1394 standard, but also

to any network only if datagram is transmitted/received in the network by specifying both a destination and an originating source by a node ID.

Fig. 47 shows the basic configuration of the data communications system in the seventh preferred embodiment of the present invention.

According to this preferred embodiment, in a data communications system in which transmitting side relay means 810 installed in relation to the first network, which is one of a plurality of physically independent networks for transferring structure data with a prescribed regular structure in prescribed transfer units, transmits a transfer unit to be transferred in the first network to another relay network and receiving side relay means 820 installed in relation to the second network, which is one of the plurality of independent networks relays the transfer unit transmitted to the relay network to the second relay network, the transmitting side relay means 810 comprises generation means 811 for generating a relay packet in a datagram format, including the transfer unit and addressed to the receiving side relay means 820 when a transfer unit transferred in the first network is inputted, and transmitting means 812 for transmitting the relay packet to a relay network. The receiving side relay

means 820 comprises separation means 821 for separating the transfer unit by breaking down the relay packet received via the relay network, reproduction means 822 for reproducing the structure data using the transfer unit obtained by the separation means 821 based on information about the prescribed regular structure for the structure data to be provided with and transmitting means 823 for transmitting the structure data to the second network in the prescribed transfer units.

In this case, since a relay packet, including a transfer unit transferred in the first network is transmitted to the receiving side relay means 820 by both the generation means 811 and transmitting means 812 of the transmitting side relay means 810, and the original structure data are reproduced from a series of relay packets by both the separation means 821 and reproduction means 822 of the receiving side relay means 820 and are provided for the output process of an output means 823, the structure data transferred in transfer units in the first network can be relayed to the second network.

In the data communications system, digital video data are transferred in prescribed transfer units in a plurality of independent networks. The reproduction means 822 of the receiving side relay means 820

comprises detection means 824 for detecting information about the head of a video frame included in an inputted transfer unit, regeneration means 825 for regenerating one video frame of structure data using the transfer unit received from the separation means 821 from when the detection means 824 detects the head of the video frame until the means 824 detects the head of a subsequent video frame, collection means 826 for collecting regeneration information about an information amount included the structure data to be regenerated by the regeneration means 825 based on the transfer unit inputted to the regeneration means 825, evaluation means 827 for evaluating the integrity of the structure data regenerated by the regeneration means 825 based on both the detection result of the detection means 824 and regeneration information and result output means 828 for outputting the structure data regenerated by the regeneration means 825 as a reproduction result based on the evaluation result of the evaluation means 827.

In this case, the regeneration means 825 regenerates structure data based on the detection result of the detection means 824 of the reproduction means 822 of the receiving side relay device 820 and both the collection means 826 and evaluation means 827

operate to evaluates the integrity of the structure data.

When this evaluation result is inputted, the result output means 828 operates, for example, to selectively output only structure data judged to be sufficiently exactly regenerated as a reproduction result and to provide the result for the process of the output means 823.

In the data communications system, the collection means 826 comprises counter means 831 for counting the number of transfer units inputted to the regeneration means 825 from when the detection means 824 detects the head of the video frame until the means 824 detects the head of a subsequent video frame and sequentially outputs regeneration information, including this counter value. The evaluation means 827 comprises a first judgment means 832 for monitoring the counter value included in the regeneration information, judging that the structure data regenerated by the regeneration means 825 are incomplete if the counter value exceeds a prescribed threshold value and outputting the judgment as an evaluation result.

In this case, when the counter value of the counter means 831 of the collection unit 826 is inputted, the

first judgment means 832 operates to judge that the structure data are incomplete if the number of transfer units included in the structure data being regenerated becomes abnormally large.

In this way, for example, if a transfer unit, including the head of a video frame is lost in the transmission process of a relay network and transfer units belonging to two different video frames are combined into one piece of structure data, the structure data can be surely eliminated for the reason that the structure data are incomplete.

In the data communications system, the collection means 826 comprises measurement means 833 for measuring an information amount included in the structure data regenerated by the regeneration means 825 based on both the detection result of the detection means 824 and information about data length that is included in each transfer unit inputted to the regeneration means 825 and outputs the regeneration information, including this measurement result. The evaluation means 827 comprises estimation means 834 for estimating the number of transfer units that have contributed to the regeneration process of the regeneration means 825 based on the measurement result included in the regeneration information and second

judgment means 835 for judging whether the information amount lost when the regeneration means 825 regenerates the structure data is allowable, based on the result of the comparison between the estimation result of the estimation means 834 and the prescribed threshold value and outputting the judgment result as an evaluation result. The result output means 828 outputs the structure data regenerated by the regeneration means 825 as a valid reproduction result and provides the data for the output process to the second network of the output means 823.

In this case, information about the number of transfer units that are included in the structure data regenerated by the regeneration means 825 are obtained by both the measurement means 833 of the collection means 826 and the estimation means 834 of the evaluation mans 827 and based on this information, the second judgment means 835 judges whether an information amount lost in the transmission process of a relay network is allowable and controls the structure data output of the result output means 828 based on this judgment result.

In this way, by providing structure data, the lost information amount of which is allowable for the process of the output means 823, as a reproduction

result, structure data to be transmitted to the second network can be secured as a reproduction result corresponding to many video frames.

Fig. 48 shows the basic configuration of the data communications system in the eighth preferred embodiment of the present invention.

According to the data communications system in this preferred embodiment, digital video data are transferred in transfer units in a plurality of independent networks. The reproduction means 822 of the receiving side relay means 820 reproduces structure data in units of video frames using a transfer unit received from the separation means 821. The output means 823 comprises first storage means 836 for storing one video frame of structure data reproduced by the reproduction means 822, second storage means 837 for storing one video frame of structure data to be transmitted, transmitting means 838 for transmitting each transfer unit stored in the second storage means 837 to the second network according to prescribed procedures, third judgment means 839 for referring to the first storage means 836 and checking whether new structure data are stored every time one video frame of structure data are transmitted and input means 840 for inputting the structure data stored in the first

storage means 836 to the second storage means 837.

In this case, when the judgment result of the third judgment means 839 is inputted, the input means 840 operates to input the transmitted structure data stored in the second storage means 837 to the transmitting means 838 in place of structure data corresponding to a subsequent video frame if a reproduction result corresponding to the subsequent video frame is not prepared in the first storage means 836 when the transmission of a reproduction result corresponding to each video frame is completed.

Fig. 49 shows the basic configuration of the data communications system in the ninth preferred embodiment of the present invention.

According to the data communications system, digital video data are transferred in prescribed transfer units in a plurality of independent networks. The transmitting side relay means 810 comprises frame counter means 841 for counting video frames transferred in the first network as structure data and generation control means 842 for controlling the stop and restart of the packet generation of the generation means 811 based on both the counter value of the frame counter means 841 and a thinning-out ratio designated by a thin-out instruction.

In this case, since when both the counter value of the frame counter means 841 and thinning-out information are inputted in the transmitting side relay means 810, the generation control means 842 operates to stop and restart the packet generation process of the generation means 811, a part of structure data transferred in the first network is converted to a series of relay packets based on the thinning-out ratio indicated by the thinning-out information described above and is transmitted to the second network via a relay network.

In this way, since frame thinning-out can be implemented by both the generation control means 842 and generation means 811, and an information amount to be transmitted via a relay network can be reduced by the transmitting side relay device 810 selectively relaying a part of structure data, the load of a relay network can be reduced and the occurrence probability of information loss, etc., can be reduced.

In the data communications system, the transmitting means 812 of the transmitting side relay means 810 comprises packet storage means 843 for storing a series of packets generated by the generation means 811, interval calculation means 844 for calculating a transmission interval at which packets are

transmitted to a relay network based on the thinning-out ratio designated by a thin-out instruction and packet output means 845 for sequentially extracting packets stored in the packet storage means 843 at transmission intervals and transmitting the packet to the relay network.

In this case, since when frame thinning-out is conducted by both the generation control means 842 and generation means 811, the packet output means 845 operates at intervals obtained by the interval calculation means 844, the series of relay packets stored in the packet storage means 843 are transmitted to the relay network at transmission intervals based on a thinning-out ratio, regardless of the transfer timing of each transfer unit in the first network.

In this way, traffic in a relay network can be averaged, the workload of the relay network can be reduced and the occurrence probability of information loss, etc., can be reduced.

Fig. 50 shows the preferred embodiment of the data communications system of the present invention.

In the data communications system shown in Fig. 50, each of two relay devices 910s and 910r comprises an IEEE1394 adapter 1011 and an Internet adapter 1013, and the two relay devices 910s and 910r further comprise

a digital video (DV) transmitting unit 911 for converting digital video data into a relay packet, which is described later, and a digital video (DV) receiving unit 921 for converting the relay packet into digital video data as described later, respectively.

In these relay devices 910s and 910r, the IEEE1394 adapters 1011 are connected to serial buses equivalent to the first and second networks, respectively, and a packet in a format stipulated in an IEEE1394 synchronous mode that is transferred using a prescribed synchronous channel (hereinafter simply called a "synchronous packet") is extracted by this IEEE1394 adapter 1011 and is inputted to the digital video unit 911.

In this digital video transmitting unit 911, a packet generation unit 912 operates according to instructions from a transmitting control unit 913 to convert a synchronous packet received from the IEEE1394 adapter 1011 to a relay packet suitable for the transfer in the Internet by attaching an appropriate header to the synchronous packet.

A transmitting buffer 914 receives a series of relay packets from this packet generation unit 912 and temporarily stores the packets. A packet reading unit 915 sequentially reads the relay packets stored in the

transmitting buffer 914 and inputs the packets to the Internet adapter 1013 according to instructions from the transmitting control unit 913.

In the digital video receiving unit 921 shown in Fig. 50, a decapsulation unit 922 breaks down the relay packets described above and separates synchronous packets. The obtained synchronous packets are sequentially stored in a receiving buffer 923.

An integrity evaluation unit 924 evaluates the integrity of digital video data consisting of synchronous packets stored in the receiving buffer 923 as described later.

Based on this evaluation result, the result output unit 925 shown in Fig. 50 reads the series of synchronous packets stored in the receiving buffer 923 and inputs the packets to the IEEE1394 adapter 1011.

Figs. 51 and 52 show the detailed configurations of the digital video transmitting and receiving units, respectively.

In the transmitting control unit 913 shown in Fig. 51, a frame detection unit 931 detects a synchronous packet, including information about the head of a video frame, in the series of synchronous packets inputted to the packet generation unit 912.

In Fig. 51, a frame counter 932 counts the number

of video frames to be composed of the series of synchronous packets inputted to the packet generation unit 912. The counter value of this frame counter 932 is inputted to a generation control unit 933.

This generation control unit 933 generates a generate instruction to stop or restart the relay packet generation process of the packet generation unit 912 based on both the counter value described above and thinning-out information stored in a control information storage unit 934. This generate instruction is inputted to the packet generation unit 912 as an instruction from the transmitting control unit 913.

The interval calculation unit 935 calculates an appropriate packet transmission interval and the packet transmission interval obtained by this interval calculation unit 935 is reported to the transmitting control unit 936.

This transmitting control unit 936 outputs a read instruction at notified packet transmission intervals, and this read instruction is inputted from the transmitting control unit 913 to the packet reading unit 915.

In the integrity evaluation unit 924 shown in Fig. 52, the frame detection unit 941 detects a

synchronous packet, including information about the head of a video frame, in the series of synchronous packets inputted to the receiving buffer 923 as a boundary of video frames, and this detection result is inputted to both a packet counter 942 and a data length counter 943.

The packet counter 942 and data length counter 943 that are shown in Fig. 52 perform counting operations based on the detection result of the frame detection unit 941 and the input of synchronous packets to the receiving buffer 923, respectively, and total the numbers of synchronous packets included one video frame separated by the boundary indicated by the detection result and the numbers of the bytes of a data section included in these synchronous packets, respectively.

In the integrity evaluation unit 224 shown in Fig. 52, a comparator 944a compares the counter value of the packet counter 942 with a prescribed threshold value Tha and a comparator 944b compares the counter value of the data length counter 943 with a prescribed threshold value Thb. The comparison results of these comparators 944a and 944b are inputted to an integrity judgment unit 945.

This integrity judgment unit 945 judges the

integrity of a video frame to be regenerated by the aggregate of synchronous packets stored in the receiving buffer 923 based on both the comparison result of the comparator 944a and the comparison result of the comparator 944b at the time when the frame detection unit 941 detects the boundary of video frames. This judgment result is reported to the result output unit 925 as the evaluation result of the integrity evaluation unit 924.

In the result output unit 925 shown in Fig. 52, a data reading unit 946 sequentially reads one video frame of synchronous packets stored in the receiving buffer 923 based on the evaluation result reported by the integrity evaluation unit 924 and inputs the packets to a transmitting queue 947.

A data output unit 948 sequentially extracts a series of synchronous packets stored in an output buffer 949 and transmits the packets to the IEEE1394 adapter 1011.

The rewriting control unit 950 shown in Fig. 52 refers to the transmitting queue 947 and controls the rewriting operation of the output buffer 949 depending on whether the transmitting queue 947 stores a new synchronous packet, every time this data output unit 948 outputs one video frame of synchronous packets.

Next, the operation of the data communications system shown in Fig. 50 is described using as an example a case where a synchronous packet transmitted to a serial bus by the digital video camera 1001, which is a node belonging to the first network, is relayed to the digital video deck 1002, which is a node belonging to the second network.

Figs. 53A and 53B are flowcharts showing the packet generation operation and the relay packet transmitting operation of the digital video transmitting unit, respectively.

Every time the IEEE1394 adapter 1011 inputs a synchronous packet, the frame detection unit shown in Fig. 51 judges whether the packet is located at the head of a new video frame, based on whether the leading three bytes of the data section of the inputted synchronous packet match a bit pattern indicating for the head of a video frame (steps B301 and B302 in Fig. 53A).

If judgment in step B302 is yes, the frame counter 932 increments the counter value C1 for indicating the number of inputted video frames (step B303), then the flow proceeds to step B304. If the judgment in step B302 is no, the flow proceeds to step B304 without any process.

In step B304, the generation control unit 933 judges whether the inputted synchronous packet should be converted to a relay packet, based on both the counter value C1 of the frame counter 932 and thinning-out information stored in the control information storage unit 934.

For example, if thinning-out information indicating that a video frame is thinned out at a thinning-out rate of 1/2 is stored in the control information storage unit 934 and if the counter value C1 of the frame counter 932 is an odd number, the generation control unit 933 judges that the synchronous packet inputted to the packet generation unit 912 is to be converted to a relay packet.

If the judgment in step B304 is yes, the packet generation unit 912 attaches a prescribed header to the inputted synchronous packet and converts the packet to a relay packet according to an instruction from the generation control unit 933 (step B305).

In this case, the packet generation unit 912 attaches both an IP header and a UDP header, each of which has the network address of the relay device 910r shown in Fig. 50 as a destination, to the head of the inputted synchronous packet.

The relay packets obtained in this way are

sequentially stored in the transmitting buffer 914 (step B306).

Then, it is judged whether the input of all the synchronous packets is completed (step B307). If the judgment is no, the flow returns to step B301 and continues the process of a new synchronous packet.

However, if the judgment in step B304 is no, the packet generation unit 912 discards the inputted packet according to an instruction from the generation control unit 933 (step B308) and then the flow proceeds to step B307.

In this way, the generation control unit 933 controls the operation of the packet generation unit 912 based on the counter value of the frame counter 932, selectively converts synchronous packets composing a part of a video frame outputted to a serial bus by the digital video camera 1001, to relay packets and provides the packets for the transmitting process of relay packets via the transmitting buffer 914.

In this way, an information amount to be transmitted to the Internet can be reduced and the transmission load of the Internet can be reduced.

The thinning-out information described above is, for example, inputted to the control information storage unit 934 prior to the start of the relay

operation of digital video data.

The format of thinning-out information is not specified and it is sufficient if the information can be an index for judging whether the relevant video frame should be thinned out by comparing the number of inputted frames with a prescribed value.

Next, the transmitting operation of relay packets stored in the transmitting buffer 914 as described above to the Internet is described.

The interval calculation unit 935 shown in Fig. 51 calculates the transmission interval of relay packets based on thinning-out information stored in the control information storage unit 934 prior to the start of the transmission of the relay packets (step B311 in Fig. 53B).

In this case, the interval calculation unit 935 calculates a transmission interval taking into consideration a transfer time corresponding to video frames thinned out based on the thinning-out information.

For example, as described above, if video frames are thinned out at a thinning-out ratio of 1/2, as shown in Fig. 54A, each relay packet composing video frames to be relayed can be transmitted during the transfer time of the thinned-out video frames (shown by dotted

lines in Fig. 54A) in addition to a transfer time of video frames selected as a relay target.

Therefore, the interval calculation unit 935 calculates transmission interval TS by multiplying the transfer interval T1 of synchronous packets in a serial bus composing the first network by the reciprocal of a value obtained by subtracting a thinning-out ratio δ from numeric value "1" (i.e., $1/(1-\delta)$ and notifies the transmitting control unit 936 of the interval.

Then, a packet reading unit 915 sequentially reads a relay packet from the transmitting buffer 914 and inputs the packets to the Internet adapter 1013 according to instructions from the transmitting control unit 936 (step B312) and then this relay packet is transmitted to the Internet.

Then, it is judged whether there is an untransmitted relay packet in the transmitting buffer 914 (step B313). If the judgment is yes, the transmitting control unit 936 repeats step B314 and waits for the lapse of the transmission interval TS described above. After the transmission interval TS elapses, the judgment in step B314 becomes yes, the flow returns to step B312 and starts the transmitting operation of a subsequent relay packet.

In this way, by determining the transmission

interval of each relay packet composing a video frame to be relayed, the timing of transmitting relay packets to the Internet can be distributed, as shown in Fig. 54B.

In this case, since a band used to transmit a relay packet can be reduced in accordance with an information amount reduced by thinning out video frames, the transmission load in the Internet can be effectively reduced.

By reducing traffic in the Internet on an average, the occurrence probability of packet loss in the transmission route via the Internet can be reduced and as a result, the possibility of reproducing a high-integrity video frame in the second network on the receiving side can be improved.

Since there is a clear correlation between the increase of transmission load and the degradation of communications quality in a "best-effort type" network, such as the Internet, the occurrence probability of relay packet loss, etc., can be suppressed by reducing the transmission load and thereby the degradation of communications quality can be suppressed.

Next, the operation of the digital video receiving unit is described.

Fig. 55 is a flowchart showing the reproducing

operation of digital video data.

As shown in Fig. 55, when a relay packet is inputted, first, a synchronous packet is separated by the decapsulation unit 922 shown in Fig. 52 eliminating both a UDP header and an IP header from the relay packet (steps B321 and B322).

In this case, the frame detection unit 941 shown in Fig. 52 judges whether the synchronous packet separated by the decapsulation unit 922 includes the leading part of a video frame as in the frame detection unit 931 (step B323).

If the judgment in step B323 is no, the packet counter 942 increments counter value PC (step B324), and the data length counter 943 refers to the synchronous header of the synchronous packet separated by the decapsulation unit 922 and adds value DM obtained by subtracting the data length of a CIP header from the data length of a data section DL to counter value DS (step B325).

Then, the integrity judgment unit 945 judges whether the counter value PC of the packet counter 942 exceeds threshold value Tha, based on the comparison result of the comparator 944a (step B326).

If the judgment in step B326 is no, the receiving buffer 923 sequentially stores synchronous packets

received from the decapsulation unit 922 (step B327).

Then, it is judged whether the input of all the synchronous packets is completed (step B328). If the judgment in step B328 is no, the flow returns to step B321 and starts the reception of a new relay packet.

If in this way, when the synchronous packets of the first network included in the relay packet received via the Internet are sequentially stored in the receiving buffer 923 and a synchronous packet, including the leading part of a new video frame, is inputted, the judgment in step B323 becomes yes.

In this case, the counter value DS of the data length counter 943 indicates the total of the data length of the data section included in a synchronous packet stored in the receiving buffer 923, and one video frame of digital video data consisting of synchronous packets transferred in the first network is regenerated as a series of synchronous packets stored in the receiving buffer 923.

In this case, if a part of one video frame of relay packets transmitted to a transmission route (shown by netting in Fig. 56A) is lost in the transmission route of a relay network (for example, the Internet), as shown in Fig. 56A, one video frame of the digital video data regenerated by the receiving

buffer 923 are incomplete.

However, if the number of lost relay packets is small, pictures and voice that are regenerated using incompletely regenerated digital video data maintain allowable quality although they include somewhat noise.

Taking this fact into consideration, the integrity judgment unit 945 judges whether the counter value of the data length counter 943 Ds exceeds threshold value Thb based on the affirmative judgment in step B323 (step B329).

If the judgment is yes, the data reading unit 946 inputs the content of the receiving buffer 923 to the transmitting queue 947 according to an instruction from the integrity judgment unit 945 (step B330), the result output unit 925 selectively transfers the digital video data of a video frame meeting quality standard indicated by threshold value Thb, to the IEEE1394 adapter 1011.

In this case, since a video frame incompletely regenerated due to the loss of a relay packet in a transmission route as well as a complete video frame with 250 synchronous packets are transmitted to the second network, the quality of each video frame degrades.

However, by also transmitting an incomplete video frame, the quality of which can be expected to meet a prescribed standard as described above, a sufficient number of video frames can be transmitted to the second network, regardless of the transmission quality in a transmission route and thereby the overall video/audio quality of enormous numbers of video frames can be guaranteed.

As the threshold value Thb, an appropriate value can be obtained based on both the result of an experiment for checking the quality of a reproduced picture, etc., obtained when several synchronous packets are lost and the loss probability of a relay packet anticipated in a transmission route.

After one video frame of synchronous packets stored in the receiving buffer 923 are outputted in this way, the receiving buffer 923 stores the first synchronous packet received from the decapsulation unit 922 as the leading synchronous packet of a video frame (step B331).

The packet counter 942 and data length counter 943 set initial value 1 and initial value DLas the respective counter values (step B332) and the flow proceeds to step B328, respectively.

However, if the judgment in step B329 is no, the

receiving buffer 923 discards a series of stored synchronous packets according to an instruction from the integrity judgment unit 945 (step B333) and then the flow proceeds to step B331.

If, as shown in Fig. 56B, a relay packet, including the leading part (shown by netting in Fig. 56B) of a video frame is lost in a transmission route, the counter value PC of the packet counter 942 continues to be incremented based on the number of synchronous packets exceeding the total n of synchronous packets for one video frame to be counted for another video frame.

In this case, since it is considered that two video frames (shown as frames 1 and 2 in Fig. 56B) are stored in an inseparable state, digital video data cannot be regenerated using a series of synchronous packets stored in the receiving buffer 923.

In this case, the integrity judgment unit 945 judges that the judgment in step B326 is yes and the flow proceeds to step B333.

In this case, since in a synchronous transfer mode based on the IEEE1394 standard, a transmitting node inserts an empty packet in order to adjust transmitting timing, the total n of synchronous packets composing one video frame becomes the total of synchronous packets with a data section Ps (hereinafter

called a "valid packet") and the number of inserted empty packets and is not constant. However, since the insertion interval of an empty packet is restricted, 20 or emptier packets are never inserted in one video frame.

Therefore, for example, if a value obtained by adding the total Pe of empty packets that can be inserted to the total Ps of valid packets composing one video frame is in advance inputted in the comparator 944a as threshold value Tha, the loss of a synchronous packet, including the leading part of a video frame, can be surely detected.

In this way, an incorrect video frame obtained by combining synchronous packets belonging to two video frames can be eliminated and thereby the influence on the second network of the low transmission quality in a relay network can be reduced.

If the number of packets, excluding empty packets, is counted based on both the detection result of the frame detection unit 941 and the number of inputted synchronous packets, an evaluation process equivalent to that in the integrity evaluation unit 924 described above is possible based on this counter value.

For example, in this case, as shown in Fig. 57, the integrity evaluation unit 924 comprises the packet

judgment unit 951 instead of the data length counter 943 shown in Fig. 52, this packet judgment unit 951 judges whether an inputted synchronous packet is valid and the packet counter 942 increments counter value PC based on this judgment result.

In this case, this packet judgment 951 judges whether the synchronous packet is an empty packet, for example, based on information about the data length of a data section indicated in the synchronous header of each synchronous packet.

In this case, the total (Ps=250) of valid packets for one video frame is inputted to the comparator 944a as threshold value Tha, and a value obtained by subtracting the allowable number of lost packets Pd from the total of the correct valid packets Ps described above is inputted to the comparator 944b as threshold value Thb.

Next, the operation of outputting the digital video data regenerated as described above to a serial bus via the IEEE1394 adapter 1011 is described.

Fig. 58 is a flowchart showing the output operation of digital video data. Fig. 59 shows the output operation of digital video data.

At the output start timing of each video frame, which is described later, the rewriting control unit

950 refers to the transmitting queue 947 and judges whether there are digital video data to be transmitted to a serial bus in the transmitting queue 947 (steps B341 and B342).

If, as shown in Fig. 59A, at timing when the output of the (k-1)-th video frame (shown as frame (k-1) in Fig. 59A) is completed the reception of all the synchronous packets composing the k-th video frame (shown as frame (k) in Fig. 59A) is completed. In this case, if one video frame of digital video data with allowable quality are regenerated, as described above, a series of synchronous packets stored in the receiving buffer 923 are inputted to the transmitting queue 947 by the data reading unit 946 shown in Fig. 52.

If in this way, the transmitting queue 947 is updated by new digital video data, the rewriting control unit 950 judges that the judgment in step B342 is yes and instructs the output buffer 949 to rewrite the content (step B343). Then, the output buffer 949 receives the series of synchronous packets stored in the transmitting queue 947 and stores the packets as an output target (step B344).

In this case, when in step B345 the data output unit 948 performs an output operation to the IEEE1394 adapter 1011, the synchronous packets composing the

k-th video frame (shown as frame (k) in Fig. 59A) are sequentially outputted to a serial bus.

When in this way, the output of one video frame of digital video data is completed, the data output unit 948 notifies the rewriting control unit 950 of the arrival of the output start timing of a new video frame (step B346) and terminates the output operation of this video frame.

For example, if the transmission interval of relay packets is adjusted following the thinning-out process of a video frame on the transmitting side or if the arrival of relay packets is delayed due to the fluctuation of transfer delay in a transmission route via the Internet, as shown in Fig. 59B, there is a possibility that the reception of all the synchronous packets composing a subsequent video frame (shown as frame (k) in Fig. 59B) may not be completed at timing when the outputting operation of the previous video frame (shown as frame (k-1) in Fig. 59B) to a serial bus.

If many relay packets are lost in a transmission route, it is judged that the quality of digital video data regenerated in the receiving buffer 923 is below the allowable value and the series of synchronous packets stored in this receiving buffer 923 are not

outputted and discarded.

In such a case, since the transmitting queue 947 is not updated by new digital video data, the rewriting control unit 950 judges that the judgment in step B342 is no and skips the rewriting process of the output buffer 949.

In this case, since there are the data of an immediately previous video frame in the output buffer 949, as shown in Fig. 59B, the data output unit 948 outputs the series of synchronous packets outputted in the immediately previous video frame (shown as frame (k-1) in Fig. 59B) to the IEEE1394 adapter 1011 again (step B345).

In this way, if the new digital video data inputted to the transmitting queue 947 are transmitted to the IEEE13294 adapter and new digital video data cannot be obtained in synchronization with the transmission timing of a new video frame, the series of synchronous packets transmitted in the immediately previous video frame can be reused.

In this way, a specified number of video frame based on the IEEE1394 standard can be surely transmitted to a serial bus, regardless of both a thinning-out process on the transmitting side and transmission quality in a transmission route and thereby digital

video data, from which high-quality pictures and voice can be reproduced as a whole can be regenerated.

As described above, by the digital video transmitting unit 911 of the relay device 910s that is installed as a node belonging to the first network, digital video data consisting of a series of synchronous packets transferred in an IEEE1394 mode in the first network can be relayed to the relay device 919r installed as a node belonging to the second network via a relay network (for example, the Internet) as a series of relay packets. By the digital video receiving unit 921 of this relay device 910r, digital video data can be regenerated from this series of relay packets and can be transmitted to the second network.

In this way, by relaying relay packets between the physically independent first and second networks via a relay network, a data communications system for transmitting synchronous packets transmitted by a node belonging to the first network to a node belonging to the second network can be implemented regarding the first and second networks described above as one virtual network.

The data communications system of the present invention is applicable not only to the relay between networks connected by a serial bus based on the IEEE1394

standard, but also to the relay between networks where digital data with the existing structure in each transfer unit with a prescribed format are transferred.

For the relay network, not only the Internet, but also a network based on a datagram type communication protocol.

Figs. 60A through 60C show problems caused by the actual application of the preferred embodiments described earlier.

In an actual practice, not only a series of single communications data, but also a plurality of related communications data are requested to be transferred. Specifically, since a series of communications data require a very broad band, the series of communications data must be divided into a plurality of pieces of communications data, each piece of data must be transmitted via a different network route and the plurality of pieces of divided communications data must be synchronized and united (Fig. 60B), if the data cannot be transferred via one route of a network (Fig. 60A). There are also a case where the video data of a multi-channel picture, such as a three-dimension picture, etc., are transferred from a plurality of video sources and a case where pictures and voice from a plurality of points are synchronized on the receiving

side at a network conference (Fig. 60C).

In the preferred embodiments described earlier, a method in which the transmitting side transfers a series of communications data (digital video data) after attaching a sequence number or an identification code that features data to the data and the receiving side properly processes the data after arraying the data by referring to the sequence number or the identification code and detecting the redundancy/loss of data, is described. However, according to this method, since the following means are not provided, problems occur when the method is actually applied.

A) A method for transferring a series of communications data via different routes

B) A method for relating a plurality of pieces of communications data to one another and synchronizing the data with one another

Fig. 61 shows the general configuration of the "relay device". Although this relay device can actually transmit and receive data simultaneously, in the description of the present invention it is assumed that the relay device simply transmits or receives data at one time.

When DV data are transmitted from the transmitting side, in a relay device 1100, an IEEE1394

adapter 1111 receives the data and terminates the line. Then, the received DV data are inputted to a DV→DV/IP conversion circuit 1112, the format of the DV data is converted into a format required to be transmitted to the Internet and the data is inputted to an Internet adapter 1114. The Internet adapter 1114 transmits the converted data to the Internet.

Conversely, if the Internet adapter 1114 receives an IP packet accommodating DV data from the Internet, the IP packet is inputted to a DV/IP→DV conversion circuit 1113, the IP packet is converted into DV data and the DV data are inputted to the IEEE1394 adapter 1111. The DV data are transmitted to a destination terminal and are displayed on the terminal.

Fig. 64 shows the problems of the preferred embodiments described earlier.

For example, if on the transmitting side, two channels of video data are multiplexed and are transmitted to the Internet, and if on the receiving side, the two channels of video data are separated and each channel of video data is viewed, in the relay device 1120 on the transmitting side, video data from the sender of video channel 1 and video data from the sender of video channel 2 must be united and transmitted to a receiving side relay device 1121 via the Internet.

However, in this case, approximately 70 to 80 Mbps of band for transfer is required for the Internet to transfer the two channels of video data. However, it is difficult to secure such a broad band. According to the protocol of the Internet, these two channels of video data are automatically divided into a plurality of pieces of data and are transferred within the Internet. On the receiving side, the receiving side relay device 1121 composes the plurality of pieces of split data and then they are broken down into each channel.

Fig. 63 shows the split communications of DV.

Split communications means communications where one piece of communications data are divided into a plurality of pieces of communications data, the plurality of pieces of divided communications data are transmitted and on the receiving side the plurality of pieces of divided communications data are united into one piece of communications data. Specifically, approximately 70 to 80 Mbps of band is required for one relay device to unite two channels of three-dimension video data, each channel of which is DV data, and to transfer the data on the Internet as one piece of communications data. If there is a broad communications band sufficient to conduct such

communications, there is no problem. However, if there is no such band, communications cannot be conducted.

Although there are generally a plurality of routes connecting a sender and a receiver in a network, communications can be implemented by dividing one piece of communications into a plurality of pieces of communications, distributing the plurality of pieces of divided communications among the plurality of different routes and transmitting the communications, if the total of the respective bands of the plurality of routes exceeds a required communications band.

Fig. 2 shows the transmitting relay device in one preferred embodiment of the present invention.

In a related patent, a frame number, sequence number, etc., are provided as identifiers, and the receiving side performs the recognition process of communications data using these identifiers. In the preferred embodiment of the present invention, to implement split communications, an identifier for identifying data, such as a "channel number", a "data generation time", the "existence/non-existence of audio data", the "existence/non-existence of video data", etc., are newly added as the additional information of the related patent. On the receiving side, data are synchronized and united using these

identifiers and the identifiers disclosed in the related patent.

The DV data of channels 1 and 2 that are inputted to an IEEE1394 adapter 1201 are composed and a DV→DV/IP conversion device 1202 maps the data from a DV data format into an IP format. Then, a communications division device 1203 divides the DV data as described below and transmits the data to the Internet via Internet adapters 1204-1 and 1204-2.

A communications data division device 1203 divides communications data into a plurality of pieces of communications data and attaches the identifiers. For a method for dividing communications data, for example, in the case of digital video data the following methods are used.

A) A method for dividing data into video data and audio data

B) A method for dividing data by a frame number, such as a pair of an odd frame and an even frame

C) A method for dividing data by a channel number

D) A method for dividing data by a sequence number

E) A method for dividing data by time information, such as an origination time, a data generation time, etc.

In this way, data can be arbitrarily divided only if an identifier can identify the split data.

As a method for designating a different route for each divided communications on the transmitting side, there are publicly known technologies, such as a technology to designate a source route and to transmit a packet, a technology to apply a multi-home to the receiving side, that is, assigning a plurality of addresses to the receiving side, etc.

The preferred embodiments of the present invention presume these technologies.

Fig. 65 shows the communications delay adjustment process of a receiving relay device in the case of a single sender.

In a receiving relay device 1214, when Internet adapters 1210-1 and 1210-2 receive data divided and transmitted from the Internet, a communication data unification device 1211 unites the plurality of pieces of divided communications data into one piece of communications data, and a DV/IP→DP conversion device 1212 extracts DV data from the DV data mapped into an IP format and transmits the DV data to DV data display devices 1215-1 and 1215-2 via an IEEE1394 adapter 1213. At this moment, the DV data display devices 1215-1 and 1215-2 extract the respective channels from the DV data.

In split communications, since a single sender can attach an arbitrary identifier on a specific basis,

communications delay can be adjusted by referring to this identifier on the receiving side. This can be implemented by adding a communications data unification device 1211 with a communications data unification function to the configuration of the related patent.

The communications data unification device 1211 checks the order, loss and redundancy of communications data using the identifier that is a single queue and is attached in the preferred embodiment of the present invention in addition to a method disclosed in the related patent, as in the frame buffer provided in the preferred embodiment describe earlier.

Fig. 66 shows the communications delay adjustment function in the case of a plurality of senders.

If each of a plurality of senders prepares and transmits communications data, the following means is used as a method for uniting the plurality of pieces of communications data.

A) A plurality of senders are synchronized and an identifier is attached as in case a single sender transmits data.

For example, in Fig. 66, sender 1220-1 that receives the transmitting data of video channel 1 and

sender 1220-2 that receives the transmitting data of video channel 2 exchange synchronization information between them. In this way, two pieces of transmitting data are synchronized and transmitted.

As synchronization means between the plurality of senders, there is a method for notifying one another of respective identifiers attached in the preferred embodiment of the present invention. For example, by notifying one another of respective sequence numbers, a unique sequence number can be obtained, if the sequence numbers are not overlapped. Therefore, the respective data can be united.

Fig. 67 shows the configuration of a transmitting relay device for synchronizing and transmitting data using a sequence number.

DV→DV/IP conversion devices 1226-1 and 1226-2 map the respective DV data of channels 1 and 2 independently received by IEEE13294 adapters 1125-1 and 1225-2, respectively, of respective transmitting relay devices into IP formats, and identifier addition units 1227-1 and 1227-2 attach sequence numbers the respective data. At this moment, synchronization devices 1228-1 and 1228-2 notify each other of respective sequence numbers to be used and prevent the same sequence number from being used. Respective data

with sequence numbers attached in this way are transmitted to Internet adapters 1229-1 and 1229-2.

Fig. 68 shows the configuration of a device for synchronizing and uniting a plurality of pieces of communications data of a plurality of senders.

Another method for uniting a plurality of pieces of communications data on the receiving side is as follows.

B) A plurality of senders independently prepare and transmit respective communications data and the plurality of pieces of communications data are united on the single receiving side.

In a video conference conducted among a plurality of points, sometimes senders are located far away from one another and there is no means for synchronizing the plurality of senders. In such a case, the senders must be synchronized only on the receiving side. For example, if a plurality of senders store and transmit respective "data origination time" or "data generation time" in identifiers, the senders can be synchronized by comparing the plurality of pieces of time on the receiving side. In this case, if the respective time of the clocks of the plurality of senders are set using a GPS (Global Positioning System), the plurality of senders can be synchronized by using the absolute time.

Even if the absolute time cannot be obtained, the plurality of senders can be synchronized by designating difference in local time for a receiver since the difference in local time between senders 1 and 2 is constant.

Fig. 69 shows another configuration for synchronizing and uniting a plurality of pieces of communications data from a plurality of senders on the receiving side.

Another method for uniting a plurality of pieces of communications data on the receiving side is as follows.

C) If there are a plurality of receivers, a plurality of senders independently prepare and transmit respective communications data and a plurality of receivers are synchronized and united on the receiving side.

In this case, by notifying one another of the identifiers of respective processed communications data a plurality of independent receivers are synchronized. For example, the synchronization can be performed when audio data are generated in a state without audio data. In this case, an empirical law that timing when a picture starts generally matches timing when a state without audio data shifts to a state with

audio data, is used. Similarly, variations, such as synchronizing when a state without video data shifts to a state with video data, synchronizing using a specific video/audio data pattern, etc., can also be used.

Fig. 70 shows the configuration of a receiving relay device used in the case of a plurality of senders.

The synchronization units 1231-1 and 1231-2 of the receiving relay device synchronize respective communications data inputted from the Internet to Internet adapters 1230-1 and 1230-2 and DV/IP→DV conversion devices 1233-1 and 1233-2 extract respective DV data from respective IP formats. In the synchronization units 1231-1 and 1231-2, synchronization devices 1232-1 and 1232-2 notify each other of synchronization timing, and the synchronization units 1231-1 and 1231-2 synchronize the two pieces of communications data. IEEE1394 adapters 1234-1 and 1234-2 transmit the respective communications data that are synchronized and converted into DV data to a display terminal as DV data.

Fig. 71 shows the synchronous configuration in the case of a plurality of senders and a plurality of receivers.

Another method for uniting a plurality of

communications data on the receiving side is as follows.
D) If there are a plurality of receivers, a communications data synchronization mechanism is provided outside the receivers and the mechanism adjusts and synchronizes a plurality of receivers.

For example, synchronization can be implemented by a human being observing video display and setting respective communications delay to each receiver. According to the preferred embodiment described earlier, once communications delay is set, the delay is maintained after that time. Therefore, if at first, respective communications delay are set to a plurality of receivers, the synchronization can be maintained after that time. There are a variety of variations using such an external synchronization device.

Fig. 72 shows the configuration of a receiving relay device using the synchronization device.

When independently receiving DV data from the receiving relay device, display devices 1240-1 and 1240-2 perform synchronizing operations using the synchronization device by the method described above, transfer the results to the synchronization unit of the receiving relay device and synchronize the two independent DV data.

The split communications in the preferred

embodiment of the present invention implements a stable communications by distributing broadband communications among a plurality of routes and making the total of the bands of the plurality of routes exceed a band required by the broadband communications. However, the effective available band of a route is affected by other communications that share a communications link with the communications and compose the route and it dynamically varies. In this case, as a result, sometimes there is a sudden shortage in a band although the band has been considered to be sufficient. Sometimes, conversely, a route becomes free although the route has been considered to have no room in band.

Figs. 73 and 74 show the influence on split communications of the dynamic change of an effective available band.

For example, in the case of Fig. 73 (initial state), more split data should be distributed to route A than those distributed to route B. However, when the state of a network changes and the state shown in Fig. 74 appears, conversely, more split data should be distributed to route B than those distributed to route A. In other words, if the division ratio can be modified based on the state of a network (effective available

band), stable communications can be implemented.

In this case, since communications data can be divided in an arbitrary ratio using a frame number or a sequence number, it is sufficient if an effective band for each route can be found in addition. Although generally it is difficult to directly measure an effective available band, the effective available band can be estimated if a network state is monitored and information is collected by providing a network information collection device. If as a result, the total of estimated effective available bands is less than a required band, the number of division is increased and data are also delivered via another new route.

Fig. 75 shows the configuration of a transmitting relay device for dynamically modifying a division method using network information.

An IEEE1394 adapter 1250 receives the two pieces of DV data of channels 1 and 2 received from two DV display devices and combines them into one piece of DV data. Then, a DV→DV/IP conversion device 1251 maps the DV data into an IP format. Then, the DV data mapped into an IP format are inputted to communications data division device 1253 and divided using the additional information described earlier. At this moment, the network information collection device 1252 obtains the

available band information of the network from the management information of the network and notifies the communications data division device 1253 of the information. The communications data division device 1253 determines how to distribute a band among channels and divides the communications data. The divided communications data are transmitted to the Internet via Internet adapters 1254-1 and 1254-2.

For the network information that can be used for the band estimation, the followings are used.

A) The packet loss ratio of a route

B) Packet data amount passing through a network interface on the transmitting side, etc.

In A), for example, if a packet loss ratio is 20% in a state where 50Mbps of divided broadband data are distributed via one specific route, the effective available band can be estimated to be $50 \times (1-0.2) = 40$Mbps. As a method for measuring the packet loss ratio, there is means for a receiver measuring a packet loss ratio using a sequence number attached to synchronous data and feeding back the information to the transmitting side, as disclosed in the related patent.

In B), the data amount of the target divided broadband communications that passes through a transmitting side network interface is checked and is

regarded as an effective available band without any process. According to this method, even if a network interface unit is bottlenecked or overflowed, an effective available band can be accurately estimated. However, in other cases, B) is inferior to A) in accuracy. However, since it is said that in the Internet, packet loss occurs in a link closest to a transmitting host or a receiving host, a nearly accurate estimation can also be expected to be obtained even by this method. Although in A) information exchange between the receiving and transmitting sides is required to obtain information, in B) information can be obtained just on the transmitting side.

In the dynamic split communications, it is preferable to rapidly reflect obtained network information on the division principle. However, conversely, if the information is reflected although there is no major change in the network information, overhead due to the modification of the division principle increases and sometimes performance degrades.

For example, it is assumed that the originally required band of broadband communications is 100Mbps and an effective available band (or the estimation value) in the case where data communications are

distributed between two routes fluctuates between 99 to 101Mbps. In this case, the effective available band decreases to 99Mbps, band shortage occurs, another new route is searched for and data are distributed via the route. However, if the effective available band increase to 101Mbps, the third route is cancelled. In this case, route search must be frequently made. In this case, by reflecting no minor change of network information on the data division principle, this phenomenon can be avoided.

Fig. 76 shows the configuration of a transmitting relay device for preventing a minor change in network information from being reflected on a data division principle.

First, the transmitting relay device comprises a network information evaluation unit 1265 for storing in advance network information obtained immediately before and digitizing the difference between the stored network information and newly obtained network information and a network information judgment unit 1266 for judging whether the difference exceeds a specific threshold value. An instruction from a network information collection unit 1264 to a communications division device 1262 is masked based on the output result of the network information judgment unit 1266.

For a method for digitizing network information, the raw numeric value of an effective available band obtained from the network information can be used. If fluctuations in the effective available band exceed the threshold value, the data division method is modified. In this case, if the effective available band is narrower than the required band, the data division method can be promptly modified and if the effective available band is broader than the required band, the data division method can be slowly modified. Specifically, if the effective available band is narrower than the required band, the data division method is promptly modified since communications data cannot be completely transmitted and communication quality degrades. If the effective available band is broader than the required band, data division method is slowly modified since there is no degradation of communications data. This can be implemented by modifying the threshold value of the network information judgment unit 1266 depending on the increase/decrease of the band.

In a reliable network, such as the Internet, sometimes the network state instantaneously degrades and immediately returns to a stable state. Specifically, since the network information collection unit 1264

picks up this instantaneous fluctuation of a network state and response to this leads to the degradation of performance, the system can also be configured so that the division principle is modified only when the network state fluctuates for a somewhat long time.

This can be implemented as follows. First, a transmitting reply device comprises a network information evaluation unit 1265 for storing in advance network information based when the current communications data division principle is determined and digitizing the difference between the stored network information and newly obtained network information, and a network information judgment unit 1266 for judging whether the difference exceeds a specific threshold value. Then, the network information judgment unit 1266 is configured to prevent an instruction from being delivered from the network information collection unit 1264 to the communication data division device as a rule by masking the instruction and to release the mask only when the difference exceeds the threshold value a plurality of consecutive times predetermined in the network information judgment unit 1266. Then, simultaneously, the reference network information is updated.

Fig. 77 shows the detailed configuration of the

data communications system.

Each of two relay devices 1330 and 1332 comprises an IEEE12394 adapter 1335 and the two relay devices 1330 and 1332 are connected to the first and second networks, respectively, via this IEEE1394 adapter 1335.

Each of the relay devices 1330 and 1332 further comprises an Internet adapter 1339 and is connected to the Internet via this Internet adapter 1339.

The DV/IP transmitting unit 1331 shown in Fig. 77 comprises an encapsulation unit 1337 for IP-encalsulates IEEE1394 packets received via the IEEE1394 adapter 1335 by a predetermined method, a packet redundancy transmitting unit 1338 for receiving the packets IP-encapsulated by the encapsulation unit 1337 and transmitting the packets to the Internet adapter 1339 after overlapping a part of the packets by a predetermined method.

Fig. 78 shows the configuration for synchronizing a plurality of pieces of data using additional information and receiving the data on the receiving side.

Fig. 78 shows the configuration for synchronizing a plurality of pieces of data using additional information in the receiving side relay

device 1402. A sender 1400 divides communications data into a plurality of pieces of data, attaches additional information to each piece of the data and transmits the plurality of pieces of data to the Internet 1401. The divided data are inputted to the receiving relay device 1402 following a plurality of network routes of the Internet 1401. The relay device 1202 extracts additional information from the received data and analyzes the content of the additional information. Then, a writing control unit 1404 controls the writing of the data into a receiving buffer 1405 based on the content of the additional information. For example, if additional information is about a "channel number", the writing control unit 1404 controls to distribute data via a different buffer for each channel. If additional information is about an "origination time" or a "data generation time", the writing control unit 1404 inputs a plurality of pieces of data with the same setting time as additional information to the receiving buffer at the same timing and outputs the plurality of pieces of data from the receiving buffer 1405 at the same timing. If additional information is about "existence/non-existence of audio data" or "existence/non-existence of video data", the writing control unit 1404 controls to match the input timing

to the receiving buffer 1405 or the output timing from the receiving buffer 1405 of data packets in which information about the existence/non-existence of audio or video data varies.